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Vertical distribution of micronutrients and heavy metals

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Abstract

The present investigation was carried out on "Vertical distribution of micronutrients and heavy metals under sewage irrigated areas" at three different villages namely, Kalupur, Basantpur and Mathurapur of Nathnagar block in Bhagalpur district. For detailed study, total nine pedon were selected for the study of micronutrients and heavy metals (As, Cd and Pb) from sewage irrigated soils. Sewage-irrigation has received much attention due to enrichment of heavy metals in soils which impacts human health and social problems; however, use of sewage water in agricultural has been an age-old practice and can contribute to a reduction in stress on the utilizable water resource, which will not only reduce disposal problems of sewage water but also contribute towards improvement of soil fertility as it contains appreciable amounts of macro and micronutrients. These metals are associated with various soil components in different ways and these associations influence both their mobility and distribution in the soil profile. The DTPA-extractable soil micronutrients *i.e.*, DTPA-Fe, Mn, Zn and Cu content varied from 8.23 to 19.22, 6.74 to 10.77, 0.41 to 2.48 and 0.05 to 1.27 mg kg^{-1} respectively in Kalupur village. Similarly in Basantpur village, DTPA-Fe, Mn, Zn and Cu content varied from 8.23 to 18.79 mg kg^{-1}, 5.43 to 10.77 mg kg^{-1}, 0.41 to 2.32 mg kg^{-1} and 0.01 to 0.91 mg kg^{-1}, respectively. Whereas, DTPA-Fe, Mn, Zn and Cu content varied from 10.70 to 18.25 mg kg^{-1}, 4.74 to 12.05 mg kg^{-1}, 1.24 to 2.48 mg kg^{-1} and 1.06 to 4.32 mg kg^{-1}, respectively in Mathurapur village. In Kalupur village, the value of DTPA-Cd, Pb and As in surface soils of sewage irrigated region varied from 0.08 to 0.48 mg kg^{-1}, 0.37 to 6.35 mg kg^{-1} and 0.11 to 0.55 mg kg^{-1} Similarly, in Basantpur village it was observed that the range varied from 0.09 to 1.41 mg kg^{-1}, 1.50 to 6.83 mg kg^{-1}, and 0.17 to 0.68 mg kg^{-1} whereas in Mathurapur village the range varied from 0.08 to 2.55 mg kg^{-1}, 1.92 to 6.35 mg kg^{-1} and 0.11 to 0.37 mg kg^{-1}. The range of heavy metal (As, Cd and Pb) concentration in Kalupur village varied from 0.10 to 0.46 mg kg^{-1}, 0.03 to 0.47 mg kg^{-1} and 0.37 to 04.32 mg kg^{-1} whereas, in Basantpur village varied from 0.10 to 0.48 mg kg^{-1}, 0.05 to 0.96 mg kg^{-1}, 1.04 to 4.65 mg kg^{-1} and in Mathurapur village varied from 0.107 to 0.551 mg kg^{-1}, 0.05 to 1.73 mg $kg^{-1}$and 1.06 to 4.32 mg kg^{-1}.

Keywords: micronutrients, sewage, heavy metals, DTPA- extractable

1. Introduction

Heavy metals (HM) have toxic and mutagenic possessions even at very few concentrations. Zinc, copper, and cadmium are among 10 toxic heavy metals with major concerns (World Health Organization, 2017) [37]. HM are toxic because of their solubility in water and the toxicity can be acute or chronic reliant on exposure-time (Dorne *et al*., 2011) [6]. HM *viz*., Pb, Cr, and Cd are the bio-toxic potential land elevated level of heavy metals poses a significant risk for human and animal health (Orisakwe *et al.*, 2012) [21]. Elevated level of HM was observed in leafy and tuberous vegetables more than grains and fruits when irrigated with wastewater (Boamponsem *et al*., 2012 [4]; Flores-Magdaleno *et al*., 2011) [8]. The transference and existence of heavy metals in soil and sediments are structured by numerous physico-chemical processes such as periodical deposition of river sediments in the floodplain, natural weathering, adsorption/desorption, oxidation/ reduction, organic matter, pH and soil texture, *etc.* (Kumar *et al.* 2012; Jayaprakash *et al.*, 2012; Zheng *et al.*, 2013) [14, 12, 40]. The transfer of accrued heavy metals in soil moves effortlessly to other ecosystems like groundwater and crops and disturb human health through water stream and the food chain (Sun *et al.*, 2013) [34].
Industrialization is the primarily root of heavy metal pollution in river and streams (Nguyen *et al*., 2016, Staley *et al*., 2015) [19, 31]. Industries such as - textiles industries, dairies, recycle facilities, fertilizer industries, tin and drug industries located besides, the river catchment are the primary origin for heavy metal pollution (Patil and Kaushik, 2016) [22].
Bhagalpur (Silk city) is the second largest city in economy and the third biggest city of Bihar. Bhagalpur is known for the production of Tassar Silk and its products. Nathnagar area in Bhagalpur district is the focal point of various industries *viz.*, silk industry, battery industry, Electroplating and automobiles repairing centers. The growth of the towns has also

triggered the progression of the industrial sector and effluents from these sectors finally find their way by making sewage sludge which carries a heavy load of heavy metals. The effluents discharge from these sources and directly dispose in Champa nala which eventually mixes up with the holy river Ganga, degrade the soil and water quality. It is having enormous sources of heavy metals which deteriorate the quality of our soils and water.

2. Material and Methods

Heavy metals contamination (HMC) in soil-ecosystem is great concern towards public health and uptake mechanism by soil and plants. Soils irrigated by wastewater accumulate heavy metals *viz.,* Pb, Cd and As in the surface and sub-surface soils. The repeated application of wastewater, heavy metals leach into the ground water or the soil solution, which were accessible for plant uptake. The work correlated to heavy metal contamination of sewage-irrigated areas in Nathnagar block were examined under various topo-sequences through deliberation of same physiographic situations. The methodology followed for accomplishing the objectives of the present study are described in this chapter under following subtitles.

Arsenic determination procedure

In 2.5 g of soil sample, 50 mL 0.5 M $NaHCO_3$ was added and it was kept for shaking (30 minutes). The suspension was filtered through Whatman no. 42 filter paper. 5 mL aliquot was taken in which 5 mL conc. HCl, 1 mL of KI and 1mL of Ascorbic acid was added. The samples were kept for 45 minutes (reduce) and then final volume was made upto 50 mL with double distilled water. The samples were ready for reading in AAS.

Available (DTPA extractable) micronutrients (Zn, Mn, Cu and Fe) and heavy metals (Pb, Cd and As), (Lindsay and Norvell, 1978) [16]

Available micro-nutrients and heavy metals were extracted with the help of mixed solution of 0.005M DTPA,0.01 M Calcium Chloride and 0.1 M Triethanolamine (TEA) at pH 7.3 (Lindsay and Norvell, 1978) [16]. 10 g of soil was taken in 100 mL conical flask and 20 mL of DTPA solution was added to it. It was shaken for 2 hours on a horizontal shaker after that it was filtered through Whatman no. 42 filter paper. The concentration of micronutrient and heavy metals was estimated with the help of Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978) [16].

Table 1: Methods of micronutrients and heavy metals analysis

SN	Properties	Method	Reference
A. Soil			
Heavy metal			
1.	Pb	Tri acid Digestion	Jackson, 1973
2.	Cd		Jackson, 1973
3.	Total Arsenic content in soil		Sparks *et al.*, 1996
4. Fe, Mn, Zn, Cu			Jackson, 1973
		DTPA extractable	Lindsay and Norvell (1978) [12]

3. Results

DTPA-extractable micro nutrients of pedon in sewage irrigated areas

A. DTPA-extractable Fe

In Kalupur village, DTPA – extractable Fe content of pedon varied between 8.23 to 19.22 mg kg^{-1} with a mean value of 15.31mg kg^{-1}. The maximum value (19.22 mg kg^{-1}) was found in P_2 at depth of 30-45cm. While, the minimum value (8.23 mg kg^{-1}) was found at a depth of 60-90 cm in P_3. Similarly in Basantpur village, DTPA – extractable Fe content of pedon varied between 8.23 to 18.79 mg kg^{-1} with a mean value of 14.24 mg kg^{-1}. The maximum value (18.79 mg kg^{-1}) was found at 0-15 and 15-30 cm, respectively in P_5. While, the minimum value (8.23 mg kg^{-1}) was found at a depth of 60-90 cm in P_6. Whereas, in Mathurapur village, DTPA – extractable Fe content of pedon varied between 10.7 to 18.25 mg kg^{-1} with a mean value of 14.61 mg kg^{-1}. The maximum value (18.25 mg kg^{-1}) was found at a depth of 15-30 cm in P_9. While, the minimum value (10.70 mg kg^{-1}) was observed at the depth of 0-15 cm in P_7.

B. DTPA-extractable Mn

In Kalupur village, DTPA – extractable Mn content of pedon varied between 6.74 to 10.77 mg kg^{-1} with a mean value of 9.01 mg kg^{-1}. The maximum value (10.77 mg kg^{-1}) was observed at a depth of 45-60 cm in P_3. While, the minimum value (6.74 mg kg^{-1}) was reported at depth of 0-15 cm in P_2. Similarly, in Basantpur village, DTPA – extractable Mn content of pedon varied between 5.43 to 10.77 mg kg^{-1} with a mean value of 9.45 mg kg^{-1}. The maximum value (10.77 mg kg^{-1}) was reported at a depth of 30-45 cm in P_6. While, the minimum value (5.43 mg kg^{-1}) was reported at depth of 0-15cm in P_4. Whereas, in Mathurapur village, DTPA – extractable Fe content of pedon varied between 4.74 to 12.05 mg kg^{-1} with a mean value of 9.54 mg kg^{-1}. The maximum value (12.05 mg kg^{-1}) was reported at depth of 15-30 cm in P_7. While, the minimum value (4.74 mg kg^{-1}) was observed at the depth of 0-15 cm in P_9.

C. DTPA- Zn

In Kalupur village, DTPA – extractable Zn content of pedon varied between 0.41 to 2.48 mg kg^{-1} with a mean value of 1.23 mg kg^{-1}. The maximum value (2.48 mg kg^{-1}) was reported at a depth of 45-60 cm in P_2. While, the minimum value (0.41 mg kg^{-1}) was reported at a depth of 60-90 cm in P_3. Similarly, in Basantpur village, DTPA – extractable Zn content of pedon varied between 0.41 to 2.32 mg kg^{-1} with a mean value of 1.31 mg kg^{-1}. The maximum value (2.32 mg kg^{-1}) was found at a depth of 45-60 cm in P_5.While, the minimum value (0.41 mg kg^{-1}) was reported at a depth of 60-90 cm in P_6.Whereas, in Mathurapur village, DTPA – extractable Fe content of pedon varied between 1.24 to 2.47 mg kg^{-1} with a mean value of 1.95 mg kg^{-1}. The maximum value (2.47 mg kg^{-1}) was found at a depth of 45-60 cm in P_9. While, the minimum value (1.24 mg kg^{-1}) was observed at the depth of 30- 45 cm in P_7.

D. DTPA-extractable Cu

In Kalupur village, DTPA – extractable Cu content of pedon varied between 0.05 to 1.27 mg kg^{-1} with a mean value of 0.60 mg kg^{-1}. The maximum value (1.27 mg kg^{-1}) was observed at a depth of 15-30 cm in P_1. While, the minimum value (0.05 mg kg^{-1}) was observed at a depth of 15-30 cm in P_2. Similarly, in Basantpur village, DTPA – extractable Cu content of pedon varied between 0.01 to 0.91 mg kg^{-1} with a mean value of 0.53 mg kg^{-1}. The maximum value (0.91 mg kg^{-1}) was found at a depth of 0-15 cm in P_5. While, the minimum value (0.01 mg kg^{-1}) was found at a depth of 45-60 cm in P_5. Whereas, in Mathurapur village, DTPA – extractable Cu content of pedon varied between 0.01 to 0.98 mg kg^{-1} with a mean value of

0.47 mg kg^{-1}. The maximum value (0.98 mg kg^{-1}) was found at a depth of 60-90 cm in P_9. While, the minimum value (0.01 mg kg^{-1}) was observed in P_7 at the depth of 30-45 cm.

DTPA-extractable heavy metals (Cd and Pb) and available As of pedon in sewage irrigated areas

A. DTPA-Cadmium

In Kalupur village, DTPA – extractable Cd content of pedon varied between 0.03 to 0.47 mg kg^{-1} with a mean value of 0.15 mg kg^{-1}. The maximum value (0.47 mg kg^{-1}) was found at a depth of 30-45 cm in P_3. While, the minimum value (0.03 mg kg^{-1}) was found at a depth of 0-15 cm in P_1. Similarly, in Basantpur village, DTPA – extractable Cd content of pedon varied between 0.05 to 0.96 mg kg^{-1} with a mean value of 0.29 mg kg^{-1}. The maximum value (0.96 mg kg^{-1}) was observed at a depth of 60-90 cm in P_4. While, the minimum value (0.05 mg kg^{-1}) was observed at depth of 0-15 cm in P_4. Whereas, In Mathurapur village, DTPA – Cu content of pedon varied between 0.05 to 1.73 mg kg^{-1} with a mean value of 0.47 mg kg^{-1}. The maximum value (1.73 mg kg^{-1}) was observed with a depth of 30-45 cm in P_9. While, the minimum value (0.05 mg kg^{-1}) was observed at a depth of 60-90 cm in P_8.

B. DTPA-Lead

In Kalupur village, DTPA – extractable Pb content of pedon varied between 0.37 to 4.32 mg kg^{-1} with a mean value of 2.09 mg kg^{-1}. The maximum value (4.32 mg kg^{-1}) was observed at a depth of 15-30 cm in P_3. While, the minimum value (0.37 mg kg^{-1}) was observed at depth of 0-15 cm in P_1.Similarly, in Basantpur village, DTPA – extractable Pb content of pedon varied between 1.04 to 4.65 mg kg^{-1} with a mean value of 2.66 mg kg^{-1}. The maximum value (4.65 mg kg^{-1}) was observed at depth of 60-90 cm and 0-15 cm (P_4 and P_6), respectively. While, the minimum value (1.04 mg kg^{-1}) was observed at a depth of 0-15 cm in P_4.Whereas, in Mathurapur village, DTPA – extractable Pb content of pedon varied between 1.06 to 4.32 mg kg^{-1} with a mean value of 2.39 mg kg^{-1}. The maximum value (4.32 mg kg^{-1}) was observed at depth of 15-30 cm in P_8. While, the minimum value (1.06 mg kg^{-1}) was observed at the depth of 30-45 cm in P_7.

C. Available Arsenic

In Kalupur village, the distribution pattern of As content from selected pedon varied from 0.10 to 0.46 mg kg^{-1} with a mean value of 0.26 mg kg^{-1}. The maximum value (0.46 mg kg^{-1}) was observed at depth of 60-90 cm in P_1. While, the minimum value (0.10 mg kg^{-1}) was observed at a depth of 15-30 cm in P_3. Similarly, in Basantpur village, it was observed that the range of As was varied from 0.10 to 0.48 mg kg^{-1} with an mean value 0.23 mg kg^{-1}. The maximum value (0.48 mg kg^{-1}) was observed at a depth of 30-45 cm in P_5. While the minimum value (0.10 mg kg^{-1}) was observed at depth of 60-90 cm in P_6 Whereas in Mathurapur village the range of arsenic varied from 0.10 to 0.55 mg kg^{-1} with a mean value of 0.22 mg kg^{-1}. The maximum value (0.55 mg kg^{-1}) was observed at a depth of 45-60 cm in P_9. While, the minimum value (0.10 mg kg^{-1}) was found at a depth of 15-30cm in P_8.

Table 4.1: DTPA-micronutrient (mg kg^{-1}) cations of pedon in sewage irrigated areas

Depth	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
Village	**Kalupur**				**Basantpur**				**Mathurapur**			
Pedon	**P_1 (50 m)**				**P_4 (50 m)**				**P7 (50 m)**			
0-15 cm	19.01	6.16	0.62	0.24	11.57	5.43	1.16	0.49	10.70	7.58	1.58	0.31
15-30 cm	16.68	7.97	0.67	1.27	15.23	9.17	0.92	0.77	11.49	12.05	1.50	0.69
30-45 cm	17.67	9.60	0.99	0.63	17.67	10.26	1.06	0.70	12.05	10.49	1.24	0.01
45-60 cm	12.98	9.58	0.76	1.01	12.98	8.54	1.22	0.64	14.99	8.52	2.32	0.40
60-90 cm	12.89	10.76	0.81	0.92	12.89	10.58	1.65	0.54	16.28	11.72	1.70	0.65
	P_2 (150 m)				**P_5 (150 m)**				**P_8 (150 m)**			
0-15 cm	17.82	6.74	2.29	0.37	18.79	8.67	2.16	0.91	15.23	6.37	2.19	0.60
15-30 cm	19.17	6.76	2.15	0.05	18.79	8.67	2.16	0.91	17.67	8.55	2.42	0.42
30-45 cm	19.22	8.79	1.50	0.43	16.73	9.68	1.54	0.63	12.98	11.92	2.28	0.65
45-60 cm	15.83	10.77	2.48	0.55	16.38	10.49	1.24	0.01	15.83	10.52	2.32	0.40
60-90 cm	14.61	10.74	1.63	0.99	14.99	10.52	2.32	0.40	14.61	9.72	1.70	0.65
	P_3 (400 m)				**P_6 (400 m)**				**P_9 (400 m)**			
0-15 cm	15.23	7.17	0.92	0.77	10.70	7.76	0.79	0.41	14.68	4.74	2.29	0.37
15-30 cm	17.67	10.26	1.06	0.70	16.68	9.05	1.50	0.69	18.25	10.76	2.15	0.05
30-45 cm	12.98	9.54	1.22	0.64	11.49	10.77	0.81	0.49	16.18	9.78	1.50	0.42
45-60 cm	9.73	9.65	0.92	0.48	12.98	9.54	1.22	0.64	15.33	9.77	2.47	0.54
60-90 cm	8.23	10.69	0.41	0.06	8.23	10.69	0.41	0.06	12.89	10.74	1.63	0.98
Overall												
Max	19.22	10.77	2.48	0.05	18.79	10.77	2.32	0.91	18.25	12.05	2.47	0.98
Min	8.23	6.74	0.41	1.27	8.23	5.43	0.41	0.01	10.70	4.74	1.24	0.01
Mean	15.31	9.01	1.23	0.60	14.24	9.452	1.31	0.53	14.61	9.54	1.95	0.47

Table 4.2: DTPA-extractable heavy metals concentration (mg kg^{-1}) of some selected pedon in sewage irrigated soils

Depth	As	Cd	Pb	As	Cd	Pb	As	Cd	Pb
Village	**Kalupur**			**Basantpur**			**Mathurapur**		
Pedon	**P_1 (50 m)**			**P_4 (50 m)**			**P_7 (50 m)**		
0-15 cm	0.26	0.03	0.37	0.16	0.05	1.04	0.13	0.09	4.07
15-30 cm	0.27	0.05	0.74	0.16	0.08	1.5	0.17	1.16	2.12
30-45 cm	0.29	0.09	1.74	0.19	0.09	1.92	0.16	0.09	1.06
45-60 cm	0.35	0.11	1.94	0.23	0.15	1.94	0.22	0.48	2.27
60-90 cm	0.46	0.14	2.19	0.29	0.96	4.65	0.18	0.45	2.01
	P_2 (150 m)			**P_5 (150 m)**			**P_8 (150 m)**		
0-15 cm	0.23	0.08	1.92	0.37	0.26	3.4	0.37	0.26	3.40
15-30 cm	0.34	0.15	3.65	0.17	0.12	3.96	0.10	0.28	4.32
30-45 cm	0.26	0.12	2.77	0.48	0.13	3.73	0.18	0.47	1.47
45-60 cm	0.34	0.15	3.57	0.22	0.30	2.01	0.34	0.15	3.57
60-90 cm	0.12	0.05	1.11	0.12	0.30	2.01	0.12	0.05	1.11
	P_3 (400 m)			**P_6 (400 m)**			**P_9 (400 m)**		
0-15 cm	0.37	0.26	3.40	0.19	0.96	4.65	0.23	0.08	1.9
15-30 cm	0.10	0.28	4.32	0.46	0.47	4.32	0.23	0.08	1.9
30-45 cm	0.18	0.47	1.47	0.18	0.28	2.19	0.17	1.73	2.79
45-60 cm	0.18	0.11	1.04	0.16	0.10	1.47	0.55	2.79	1.08
60-90 cm	0.16	0.1	1.04	0.10	0.09	1.03	0.12	1.08	2.71
Overall									
Max	0.46	0.47	4.32	0.48	0.96	4.65	0.55	2.79	4.32
Min	0.10	0.03	0.37	0.10	0.05	1.04	0.10	0.05	1.06
Mean	0.26	0.15	2.09	0.23	0.29	2.66	0.22	0.47	2.39

4. DTPA-heavy metal nutrients of surface soil in sewage irrigated areas

A. Available Arsenic

In Kalupur village, the available As content of soils varied from 0.11 mg kg^{-1} to 0.55 mg kg^{-1} with a mean value of 0.33 mg kg^{-1}. Similarly in Basantpur village, it was observed that the available As content of soils varied from 0.17 to 0.68 mg kg^{-1} with a mean value of 0.33 mg kg^{-1} whereas in Mathurapur, the available As content of soils varied from 0.11 mg kg^{-1} to 0.37 mg kg^{-1} with a mean value of 0.21 mg kg^{-1}.

B. DTPA-Cd

In Kalupur village, DTPA-Cd of soils varied from 0.08 to 0.48 mg kg $^{-1}$ with a mean value of 0.26 mg kg^{-1}. Similarly, in Basantpur village, DTPA-Cd of soils varied from 0.09 mg kg^{-1} to 1.41 mg kg^{-1} with a mean value of 0.48 mg kg^{-1} whereas in Mathurapur the range was varied from 0.08 mg kg^{-1} to 2.55 mg kg^{-1} with a mean value of 0.81 mg kg^{-1}.

C. DTPA-Pb

In Kalupur village, DTPA- Pb content of soils varied from 0.37 mg kg^{-1} to 6.35 mg kg^{-1} with a mean value of 4.22 mg kg^{-1}. Similarly, the DTPA- Pb content of soils varied from 1.50 to 6.83 mg kg^{-1} with a mean value of 4.25 mg kg^{-1} in Basantpur village. Whereas, the DTPA- Pb content of soils varied from 1.92 mg kg^{-1} to 6.35 mg kg^{-1} with a mean value of 3.63 mg kg^{-1} in Mathurapur.

5. Discussion

DTPA-micronutrient cations of selected pedon in sewage irrigated soils

Apart from major nutrients, DTPA- extractable micronutrients have been studied in some selected pedon in sewage irrigated soils in Nathnagar block. In perpetuation of results**,** DTPA-Fe status varied from 8.23 mg kg^{-1} to 19.22 mg kg^{-1}with mean 14.72 mg kg^{-1}. While deliberation of critical limit of DTPA-Zn was 4.50 mg kg^{-1} followed by Lindsay and Norvell (1978) [16]. It can be justify the soils belong to sewage irrigated soils falls sufficient in nature and well supplied of Fe. Similar results were reported in old alluvial plain by Sakal *et al.*, (1988) [25] and Prasad *et al.*, (1991) [23]. Similarly, DTPA-Mn status was sufficient in nature and it was varied from 4.74 mg kg^{-1} to 12.05 mg kg^{-1} with mean 9.33 mg kg^{-1} except few samples. However, critical limit of DTPA-Mn was 5 mg kg^{-1} in respect of Indian soils (Finck and Venketeswarlu, 1982) [7].Therefore, it can be concluded that, soils of sewage irrigated soils belong to new alluvial plain justify the well rich Mn status in Nathnagar Block.

Similarly, DTPA-Zn content was varied from 0.41 mg kg^{-1} to 2.48 mg kg^{-1} with mean 1.49 mg kg^{-1} except lower layer of pedon 3 and pedon 6 at 60-90 cm depth layer which was reported 0.41 mg kg^{-1} Zn. However, some of the scientist reported critical limit of DTPA-Zn was 0.75 mg kg^{-1} in Indian soils (Finck and Venketeswarlu, 1982) [7]. Therefore, it can be concluded that, sewage irrigated soils in some selected pedon was sufficient in Zn status. In perpetuation of similar results was corroborated by Kumar *et al*., (2013) [15] in soils of Khammam district of Andhra pradesh and they reported that soils sufficient of available zinc due to variable intensity of pedogenic process and made the complex with organic matter. Whereas, DTPA-Cu status was varied from 0.01 mg kg^{-1}to 1.27 mg kg^{-1} with mean 0.53 mg kg^{-1} of some selected pedon in sewage irrigated soils. Overall, results observed that, DTPA-Cu was sufficient in nature except pedon5 (45-60 cm) and pedon 7 (30-45cm), respectively. From these results, it can be concluded that soils belong to sewage irrigated soils well supplied of Cu and justify the results of old alluvial plain in Bihar soils (Sakal *et al*., 1988 and Prasad *et al*., 1991) [25, 23].

Heavy metals of some selected pedon in sewage irrigated soils

The As content of some selected pedon in sewage irrigated soils was varied from 0.10 mg kg^{-1} to 0.55 mg kg^{-1} with mean 0.23 mg kg^{-1}. Whereas, Cd content in sewage irrigated soils of some selected pedon was varied from 0.03 mg kg^{-1} to 1.73 mg kg^{-1} with mean 0.22 mg kg^{-1} and Pd content was varied from 0.37 mg kg^{-1} to 4.65 mg kg^{-1} with mean value 2.38 mg kg^{-1}. Overall, results was interpreted that As accumulation was observed towards irregular pattern in pedogenic layer. However, it may be conclude that As, Cd and Pb content of selected pedon was observed in few amounts because of enormous amount of active calcium carbonate present in their respective depth with increasing of soil pH. Further, results was evaluated by (Smith and Giller, 1992) [29] and they reported that precipitation of hydroxides, carbonates or the formation of insoluble organic complexes (Smith and Giller, 1992) [29] fix heavy metal status in selected pedon and unable to made for plant uptake. Apart from this, it influences the mobility and bioavailability of heavy metals and its dynamic changes depend on pH after irrigation (Nigam *et al*., 2001) [20].

DTPA- extractable micronutrients of surface soils in sewage irrigated

The DTAP- micronutrients cationic (DTPA-Fe, Mn, Zn and Cu) of surface soils from sewage irrigated areas have been evaluated and results revealed that DTPA-Fe of sewage irrigated surface soils was varied from 10.29 mg kg $^{-1}$ to 28.19 mg kg^{-1} with mean 3.88 mg kg^{-1}. It might be due to accumulation of humic fibric material in surface soils besides incidence of reduced situation (Prasad and Sakal, 1991) [23] in subsurface layer and these types of situation most prevalence in sewage irrigated soils. There was significant negative correlation was observed between pH v/s Fe (r = 0.270*). The significant positive correlation between Fe v/s K_2O (r = 0.518**), Cd (r = 0.336**), Fe (r = 0.378**), Zn (r = 0.483**) and Cu (r = 0.313**), respectively. Apart from these, there was significant negative correlation between with soil pH (r = 0.270*).

The DTPA-Mn of sewage irrigated surface soils was varied from 0.67 to 15.08 mg kg $^{-1}$ with mean 5.30 mg kg^{-1}. It might be due release of chelated Mn from organic compound (Sharma and Choudhary, 2007) [27]. The significant positive correlation between Mn v/s Pb (r = 0.240*) and significant negative correlation between Mn v/s Cd (r = 0.405**), Mn v/s Zn (r = 0.634**), Mn v/s Cu (r = 0.526**) at the level of significance.

The DTPA-Zn of sewage irrigated surface soils varied from 0.62 mg kg $^{-1}$ to 3.37 mg kg^{-1} with mean 0.66 mg kg^{-1}. There was significant positive correlation between Zn v/s K_2O (r = 0.272*), Zn v/s Cu (r = 0.486**), Zn v/s Fe (r = 0.483**) and significant negative correlation between Zn v/s Mn (r = -0.634**) at the level of significance.

Similarly, DTPA-Cu of sewage irrigated surface soils was varied from 1.01 mg kg^{-1} to 68.58 mg kg^{-1} with mean 15.05 mg kg^{-1}. The significant positive correlation between Cu v/s $CaCO_3$ (r = 0.350**), N (r = 0.350**), P_2O_5 (r = 0.374**), Cd (r = 0.375**), Pb (r = 0.418**), Zn (r = 0.486**) and Fe (r = 0.313**), respectively. Further, significant negative correlation was observed between Cu v/s Mn (r = 0.526**) at level of significance.

Apart from these, sewage irrigation after 20 years, significant build-up of DTPA extractable Zn, Cu and Fe in sewage-irrigated soils (Rattan *et al*., 2005) [24].

Vertical distribution of heavy metal of surface layer from sewage irrigated areas

The vertical distribution of heavy metal of superficial layer from sewage irrigated soils have been evaluated and results revealed that As content was varied from 0.10 to 0.68 mg kg $^{-}$

[1]with mean 0.35 mg kg^{-1}.It mightbe due to concentration of arsenic depends on the clay content and metal oxide content in soils. There was a significant negative correlation observed between As v/s Cd (r = - 0.276*) and Pb (r = - 0.268*), respectively.

Furthermore, arsenic contamination in sewage irrigated soils mainly due to geogenic activity in soils. Apart from these, adsorption of arsenic is significantly high in soils due to more or less high clay content and clay content decreases with depth of soil (Huq *et al.*, 2003, Samal *et al*., 2010) [10, 26]. They further reported that clay or clayey soil contains more FeOOH when compared to sandy soil, and therefore, clayey soil has adsorbed more arsenic. Whereas, Cd content was varied from 0.08 mg kg^{-1} to 20.55 mg kg^{-1} with mean 0.49 mg kg^{-1}. There was significant highly positive correlation between Cd v/s Cu (r = 0.375), Fe (r = 0.336**) and significant negative correlation with As (r = -0.276*) and DTPA- Mn (r = -0.405**), respectively. Similar findings were reported by various scientist (Tabari *et al.,* 2008; Behbahaninia and Mirbagheri, 2008; Zhao *et al.,* 2010) [35, 3, 39]. Similarly, Pb content varied from 0.37 mg kg^{-1} to 6.83 mg kg^{-1} with mean 4.03 mg kg^{-1}. The higher content of extractable heavy metals in surface layer revealed that low mobility of these metals (Brar *et al.*, 2000; Khurana *et al*., 2004) [5, 13] in the superficial layer. The largest fraction of Cd, Pb, and As sewage irrigated soils was strongly bound in a residual form, while exchangeable and the other labile fractions were negligible. Hence, they were partially taken up by plants as well as partly accumulated in soil (Wang *et al*., 2003; Singh *et al*., 2009) [36, 28]. There was highly significant correlation between Pb v/s Cu (r = 0.418**) and Fe (r = 0.378**), respectively at (5** and 1* percent) level of significance. Further, there was significant negative correlation was observed with As (r = -0.268*) respectively at level of significance (5** and 1* percent). The mobility of heavy metals in sewage irrigated soil was very slow and more than 90% of Cd, Ni, and Pb accumulated in superficial layer (Streck and Richter, 1997) [32].

6. Conclusion

- Most of the sample belongs to sewage irrigated soils were deficient in Nitrogen, medium to high in phosphate and sufficient range was found in potash status.
- The heavy metals content (As, Cd and pb) shows increasing as well as irregular trend with increasing the depth.

7. References

1. Adelekan BA, Alawode AO. Contributions of municipal refuse dumps to heavy metals concentrations in soil profile and ground water in Ibadan Nigeria. Journal of Applied Bioscience. 2011; 40:2727-2737.
2. Ahumada I, Mendoza J, Ascar L. Sequential extraction of heavy metals in soil irrigated with waste water. Communication in Soil Science and Plant Analysis. 1999; 30:1507-1519.
3. Behbahaninia A, Mirbagheri SA. Investigation of heavy metals uptake by vegetable crops from metal-contaminated soil. World Academy of Science, Engineering and Technology. 2008; 43:53-55.
4. Boamponsem GA, Kumi M, Debrah I. Heavy metals accumulation in cabbage, lettuce and carrot irrigated with wastewater from Nagodi mining site in Ghana. Int J Sci Technol Res. 2012; 1:124-129.
5. Brar MS, Malhi SS, Singh AP, Arora CL, Gill KS. Sewage water irrigation effects on some potentially toxic trace elements in soils and potato plants in North Western India. Canadian Journal of Soil Science. 2000; 80:465-471.
6. Dorne JLCM, Kass GEN, Bordajandi LR, Amzal B, Bertelsen U, Castoldi AF. Human risk assessment of heavy metals: principles and applications. In: Sigel A, Sigel H, Sigel RK (eds) Metal ions in life sciences. Royal Society of Chemistry. 2011, 27-60.
7. Finck A, Venkateswarlu I. Chemical properties and fertility management of vertisols. Vertisols and rice soils of the tropic, Symposium paper II. 12th Int. COl1g. Soil Sci., New Delhi, 1982.
8. Flores-Magdaleno H, Mancilla-Villa OR, Mejia-Saenz E, Olmedo-Bolanos MDC, Bautista-Olivas AL. Heavy metals in agricultural soils and irrigation wastewater of Mixquiahuala, Hidalgo, Mexico. African Journal of Agricultural Research. 2011; 6:5505-5511.
9. Gholamabbas S, Majid A, Sayed FM, Karim CA, Brian KR, Rainer S. Transport of Cd, Cu, Pb and Zn in a calcareous soil under wheat and safflower cultivation - a column study. Geoderma. 2010; 154:311-320.
10. Huq SMI, Rahman A, Sultana N. Extent and severity of Arsenic Contamination in Soils of Bangladesh. Fate of Arsenic in the Environment. 2003.
11. Jackson ML. Soil Chemical Analysis, New Delhi. Prentice Hall of India. 1967, 1973.
12. Jayaprakash M, Nagarajan R, Velmurugan PM, Sathiyamoorthy J, Krishnamurthy RR, Urban B. Assessment of trace metal contamination in a historical fresh water canal (Buckingham Canal), Chennai, India. Environmental Monitoring and Assessment. 2012; 184(12):7407-7424.
13. Khurana MPS, Singh M, Nayyar VK.Assessment of heavy metal contamination in soils and plants irrigated with sewage waters containing industrial effluents in District Amritsar, Punjab, Indian Journal of Environment and Ecoplantation. 2004; 8:221-228.
14. Kumar A, Ramanathan AL, Prabha S, Ranjan RK, Ranjan S, Singh G. Metal speciation studies in the aquifer sediments of Semria Ojhapatti, Bhojpur District, Bihar. Environmental Monitoring and Assessment. 2012; 184(5):3027-3042.
15. Kumar MJ and Rao MV. Analysis of Physico Chemical Parameters in Relation to Soil Fungi of Bhadrachalam Forest, Khammam District, Andhra Pradesh, India. Journal of Advanced Forest Science and Management. 2013; 17-24.
16. Lindsay WL, Norvell WA. Development of DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of America Journal. 1978; 42:421-428.
17. Mitra A, Gupta SK. Effect of sewage water irrigation on essential plant nutrient and pollutant element status in a vegetable-growing area in Calcutta. Journal of Indian Society of Soil Science. 1999; 47:99-105.
18. Nabuloa G, Younga SD, Black CR. Assessing risk to human health from tropical leafy vegetables grown on contaminated urban soils. Science of Total Environment. 2010; 408:5338-5351.
19. Nguyen TTH, Zhang WG, Li Z, Li J, Ge C, Liu JY *et al*. Magnetic properties of sediments of the Red River, Vietnam: effect of sorting on the source-to-sink pathway and its implications for environmental reconstruction. Geochemistry, Geophysics, Geosystems. 2016; 172.

20. Nigam R, Srivastava S, Prakash S, Srivastava MM. Cadmium mobilisation and plant availability-the impact of organic acids commonly exuded from roots. Plant and Soil. 2001; 230:107-113.
21. Orisakwe OE, Nduka JK, Amadi CN, Dike DO, Bede O. Heavy metals health risk assessment for population via consumption of food crops and fruits in Owerri, South Eastern, Nigeria. Chemistry Central Journal. 2012; 6:77-83.
22. Patil S, Kaushik G. Heavy metal assessment in water and sediments at Jaikwadi dam (Godavari river) Maharashtra, India. International Journal of Environment. 2016; 5(2):75-88.
23. Prasad R and Sakal BR. Effect of submergence on native DTPA Extractable Zn, Fe, Cu and Mn in some old alluvial rice soils of South Bihar. Journal of Indian Society of Soil Science. 1991; 39(4):773-776.
24. Rattan RK, Dutta SP, Chhonkar PK, Suribabu K, Singh AK. Long-term impact of treated wastewater irrigation on calcisol fertility. Agricultural Science. 2005; 3:310-322.
25. Sakal R, Singh AP, Singh SP. Distribution of available zinc, copper, iron and manganese in old alluvial soils as related to certain soil characteristics. Journal of Indian Society of SoilScience. 1988; 36(1):59-63.
26. Samal AC, Bhattacharya P, Santra SC. Transfer of arsenic from contaminated ground water and soils to crop vegetables: A study in Gangetic delta of West-Bengal, India. Arsenic in Geosphere and Human disease Jean. CRC Press, Taylor and Francis, London. 2010; 197-199.
27. Sharma JC and Choudhary SK. Vertical distribution of micronutrient cations in relation to soil characteristics in lower Shivaliks of Solan districts in North–West Himalayas. Journal of the Indian Society of Soil Science. 2007; 55(1):40-44.
28. Singh A, Sharma RK, Agrawal M, Marshall F. Effects of wastewater irrigation on physicochemical properties of soils and availability of heavy metals in soil and vegetables. Communications in Soil Science and Plant Analysis. 2009; 40:3469-3490.
29. Smith SR, Giller KE. Effective Rhizobium *leguminosarum biovar Trifolii* present in five soils contaminated with heavy metals from long-term applications of sewage sludge or metal mine spoil. Soil Biology and Biochemistry. 1992; 24(8):781-788.
30. Sparks DL (Ed.) Methods of Soil Analysis. Part 3: Chemical Methods. Soil Science Society of America, Madison. 1996.
31. Staley C, Johnson D, Gould TJ, Wang P, Phillips J, Cotner JB, Sadowsky MJ. Frequencies of heavy metal resistance are associated with land cover type in the Upper Mississippi River. Science of Total Environment. 2015; 511:461-468.
32. Streck T, Richter J. Heavy metal displacement in a sandy soil at the field scale: I. Measurements and parameterization of sorption. Journal of Environmental Quality. 1997; 26:49-56.
33. Subbiah BV, Asija GL. A rapid procedure for the detennination of available nitrogen in soils. Current Science. 1956; 25:259-260.
34. Sun C, Liu J, Wang Y, Sun L, Yu H. Multivariate and geostatistical analyses of the spatial distribution and sources of heavy metals in agricultural soil in Dehui, Northeast China. Chemosphere. 2013; 92(5):517-523.
35. Tabari M, Salehi A, Ali-Arab AR. Effects of waste water application on heavy metals (Mn, Fe, Cr and Cd) contamination in Black Locust Stand in semi-arid zone of Iran. Asian Journal of Plant Science. 2008; 7(4):382-388.
36. Wang Z, Chang C, Wu L, Crowley D. Assessing the soil quality of long-term reclaimed wastewater-irrigated cropland. Geoderma. 2003; 114:261-278.
37. World Health Organization. [online] Available at:www.who.int/entity/ifcs/documents/forums/forum5/8inf_rev1_en.pdf - 86k - 997k. 2017.
38. Yusuf AA, Arowolo TA, Bamgbose O. Cadmium, copper and nickel levels in vegetables from industrial and residential areas of Lagos city, Nigeria. Food and Chemical Toxicoogy. 2003; l41:375-378.
39. Zhao Y, Chen Z, Li Q, Liu X. Heavy metal contents and chemical speciations in sewage-irrigated soils from the eastern suburb of Beijing, China.19th World Congress of Soil Science, Soil Solutions for a Changing World, 1-6 August Brisbane, Australia. 2010.
40. Zheng SA, Zheng XQ, Chen C. Transformation of metal speciation in purple soil as affected by waterlogging. International Journal of Environmental Science and Technology. 2013; 10(2):351-358.